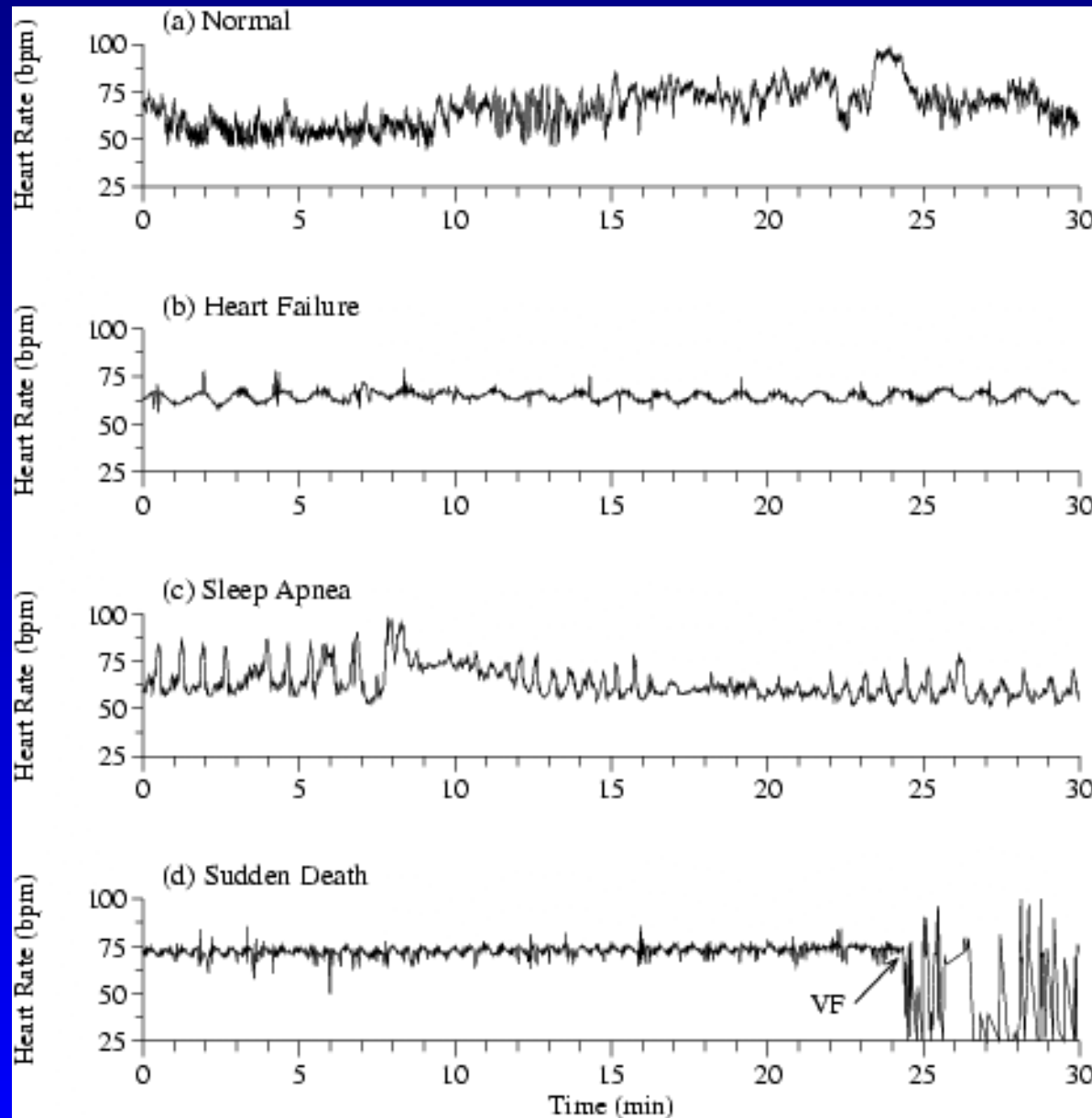# Potential HHT Applications in Biomedical Signal Analysis

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NIH Research Resource for Complex Physiologic Signals

Biomedical signals are typically *nonlinear* and *nonstationary*

Opportunities for HHT

- HHT provides a powerful framework to analyze complex biomedical signals by enabling us to explore instantaneous frequency and energy on multiple time scales.
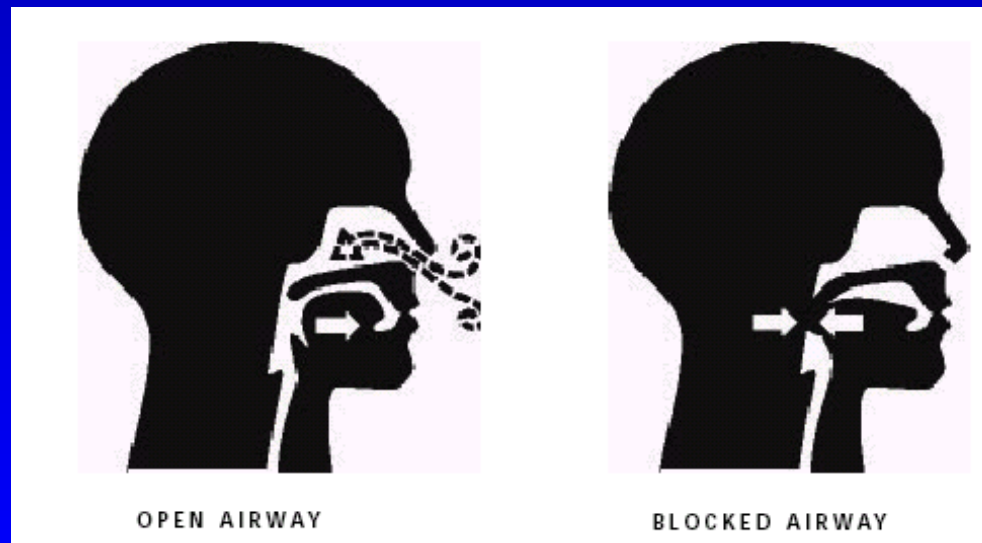
Three Clinical Examples

- Sleep apnea detection

- Seizure forecasting

- Stroke risk assessment

Sleep Apnea
(intermittent cessation of breathing)

- Prevalence: 18 million Americans
- Challenge: clinically under-diagnosed due to the prohibitive expense of screening and follow-up studies
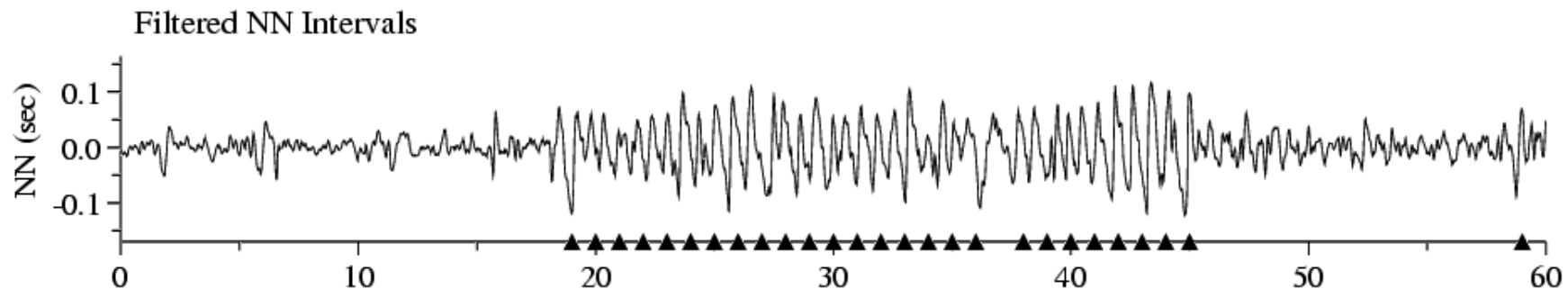

OPEN AIRWAY   BLOCKED AIRWAY

- Sleep apnea is associated with increased morbidity and mortality.

- Need for simple, easily implemented screening and detection techniques.

Sleep laboratory screening

Prolonged sleep apnea frequently associated with 0.01 - 0.04 Hz oscillations in heart rate

RR Interval Oscillations During Sleep Apnea
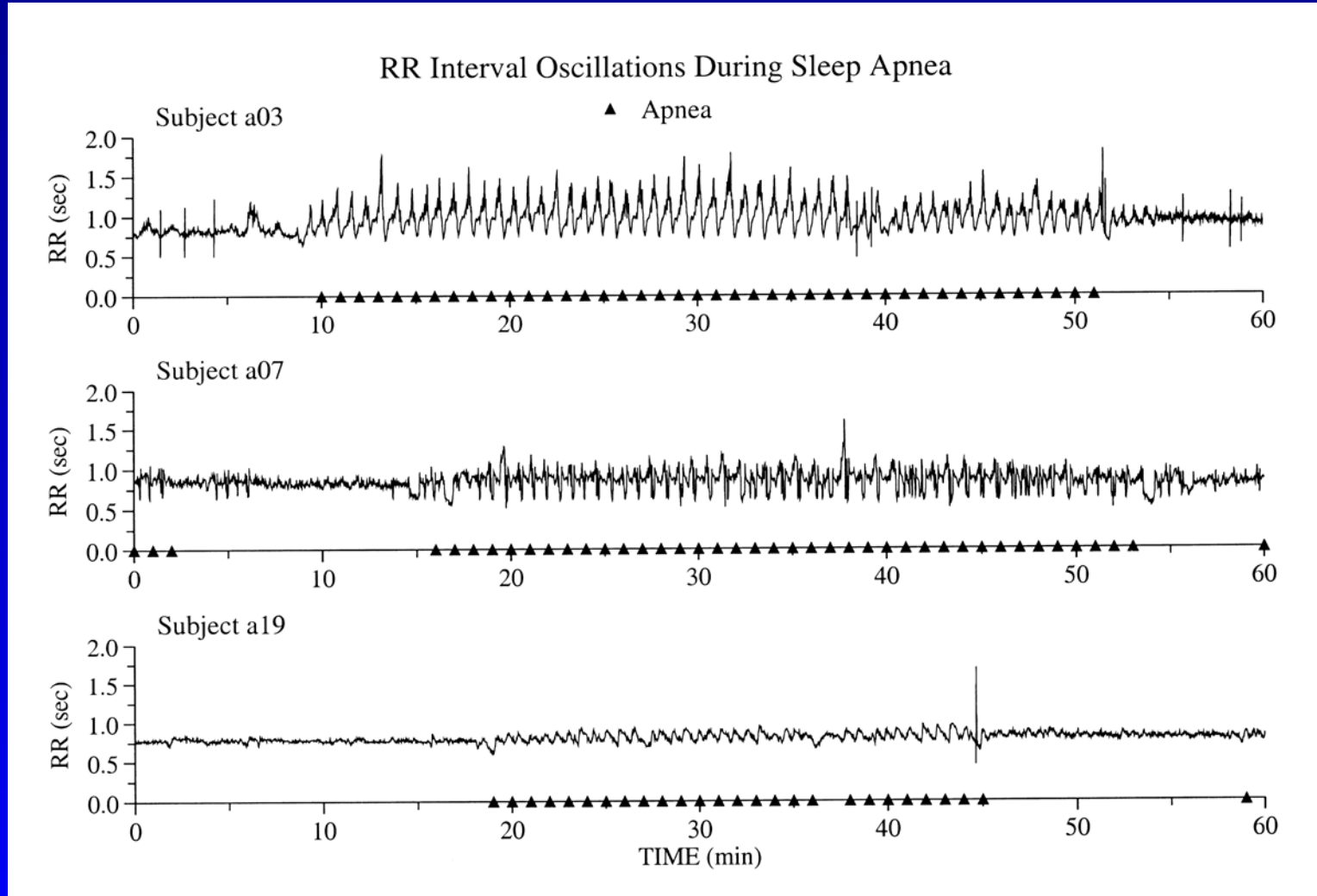
Hilbert transform-based technique can be used to reliably detect sleep apnea
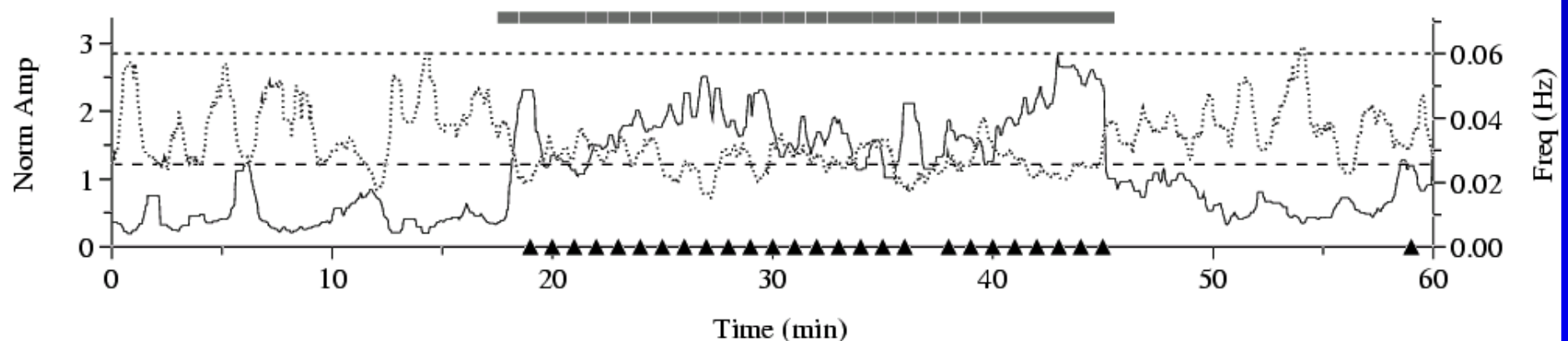
Preliminary Results

- Training Database:
  26 out of 30 subjects (86.6%)
  13985 out of 17045 minutes (82.1%)

- Test Database:
  28 out of 30 subjects (93.3%)
  14591 out of 17268 minutes (84.5%)

Mietus JE, Peng CK, Ivanov PCh, Goldberger AL. *Computers in Cardiology* **27**:753-756, 2000.
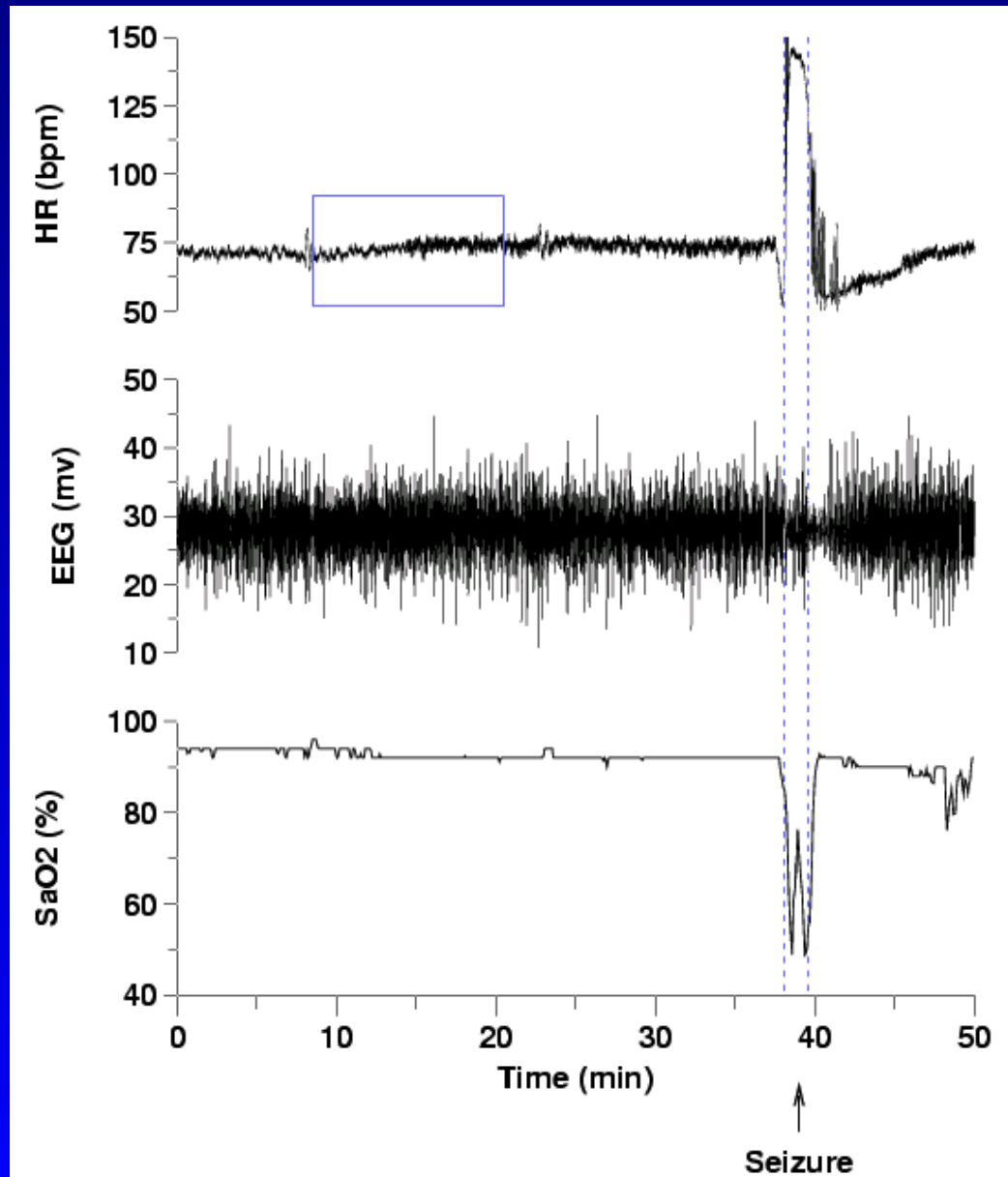
Epileptic Seizures
(uncontrolled firing of brain neurons)

- Prevalence: 2.5 million Americans
- Cost: $3.5 billion yearly
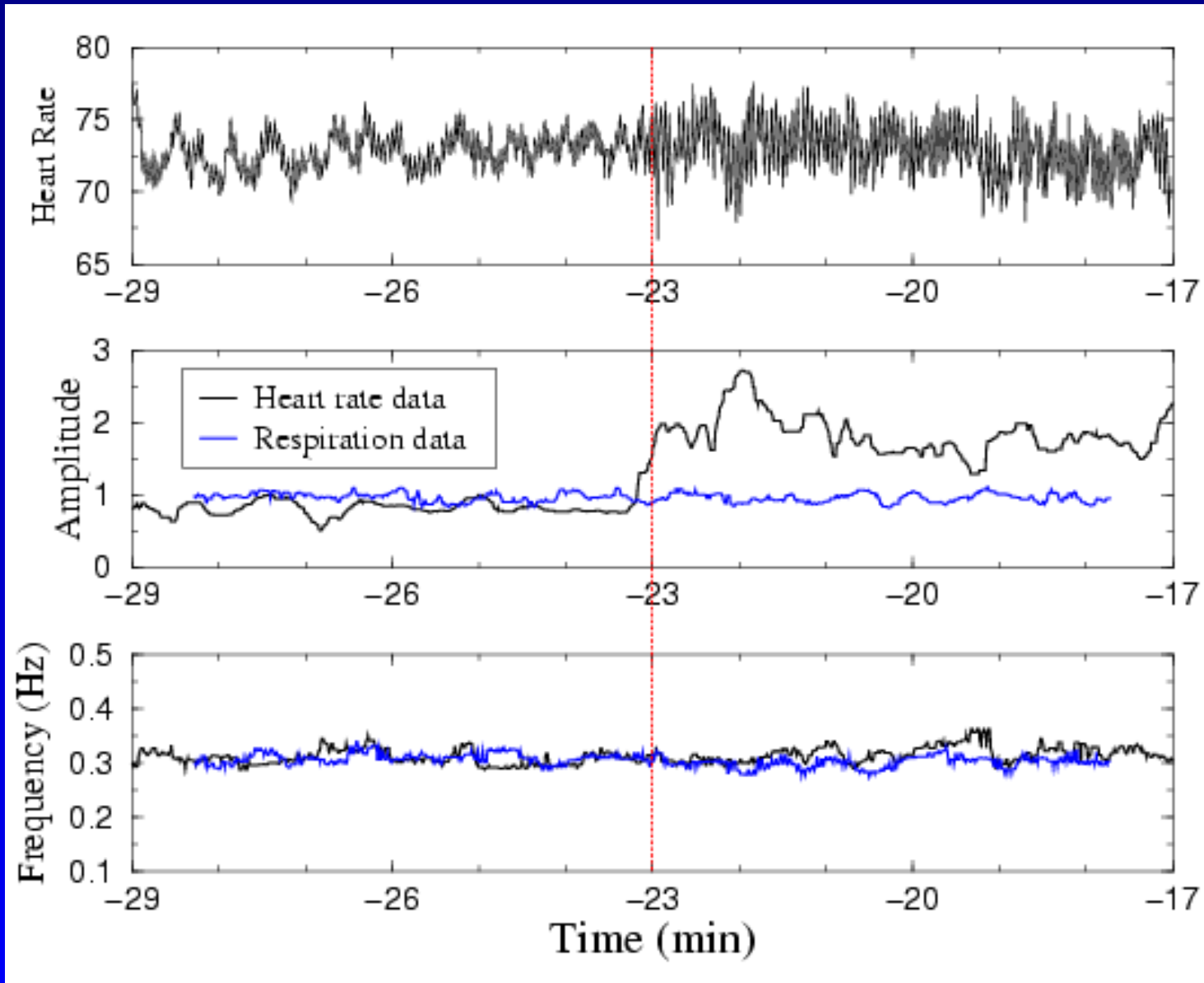- Challenge: how to predict seizures

One channel of an electroencephalogram (EEG) recording during a temporal lobe seizure
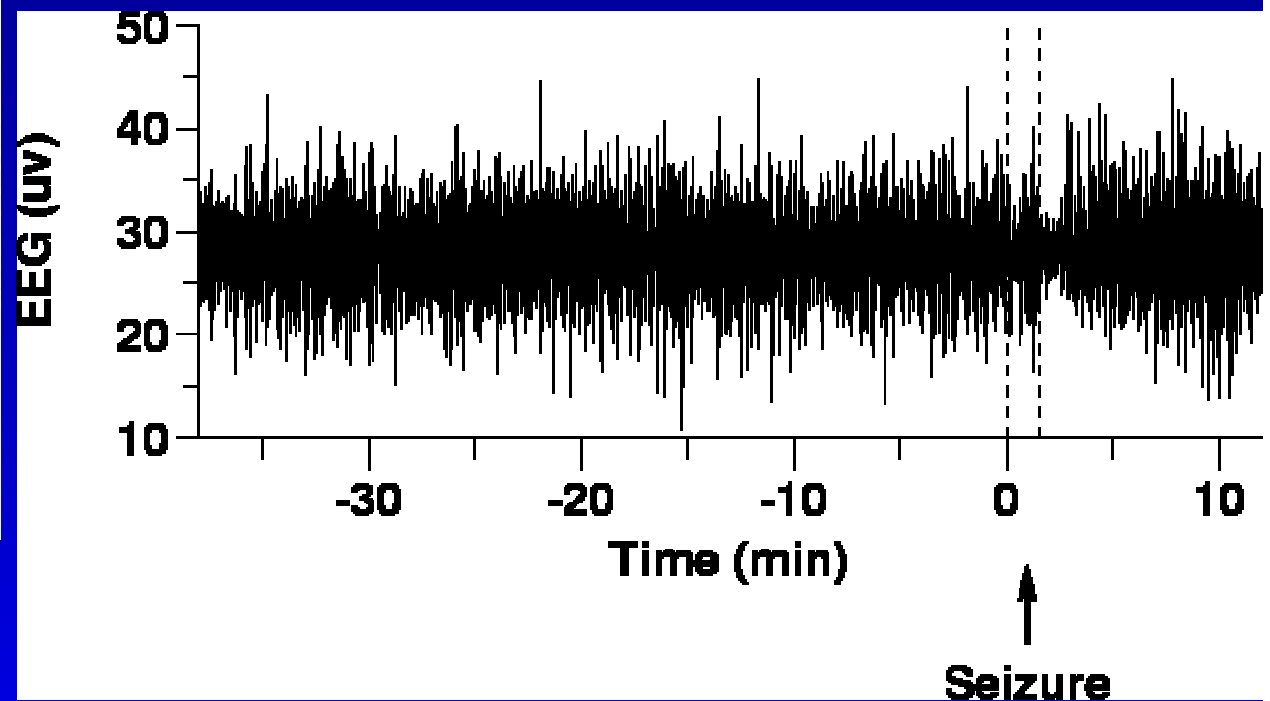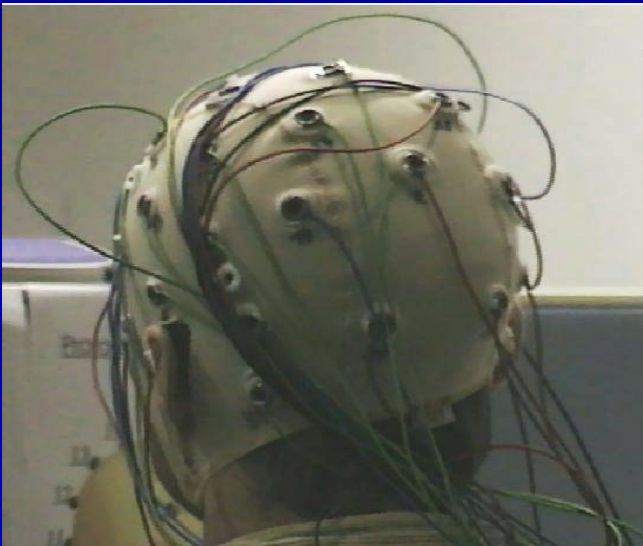
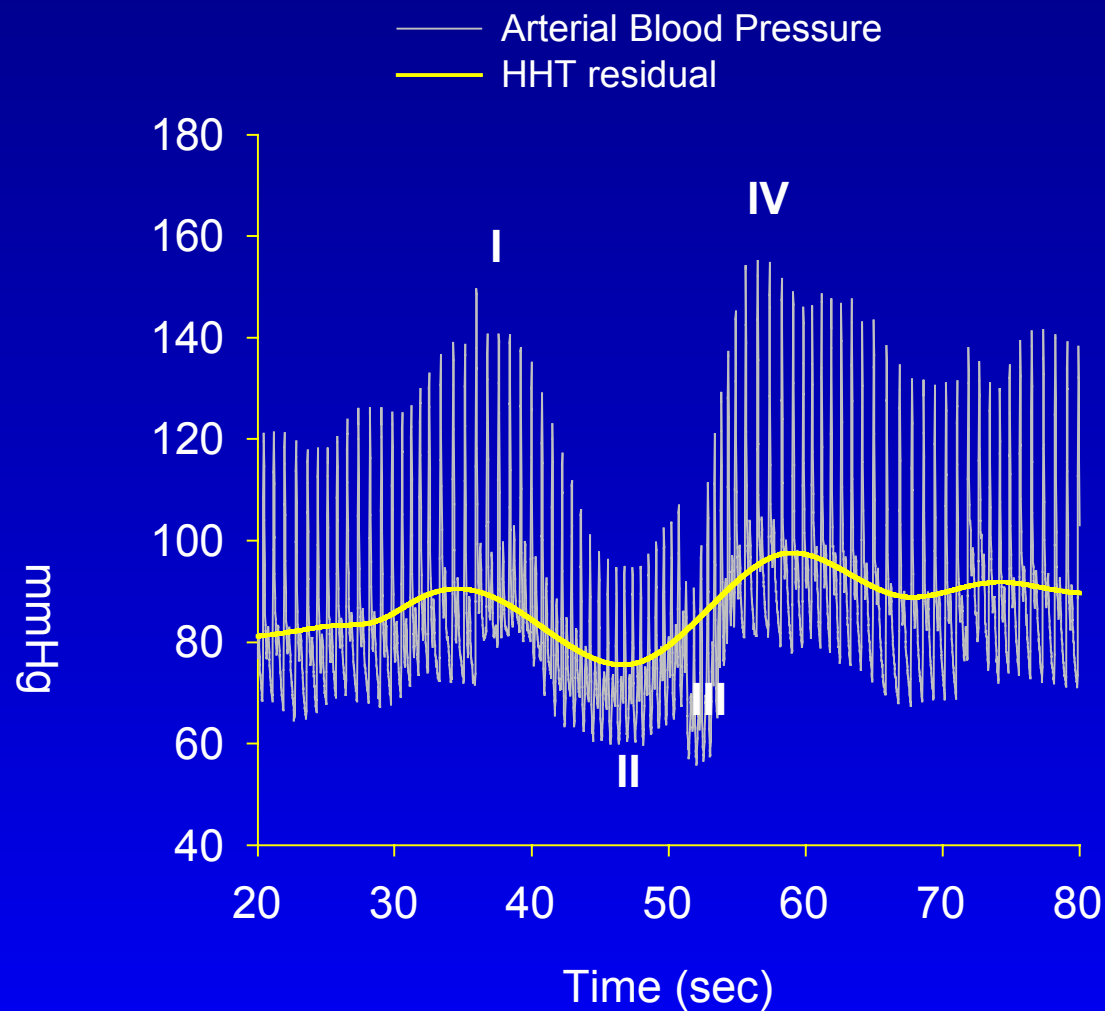# Cardiopulmonary Instability with Seizure

HHT Analysis

Stroke

- Prevalence: 3rd leading cause of U.S. death
- Cost: $170 billion
- In healthy young subjects, cerebral blood flow is stable independent of posture or other perturbations
- Cerebral adaptability declines with age
- Challenge: how to quantify risk factors in elderly subjects?

Valsalva Maneuver Dynamics

HHT Representation
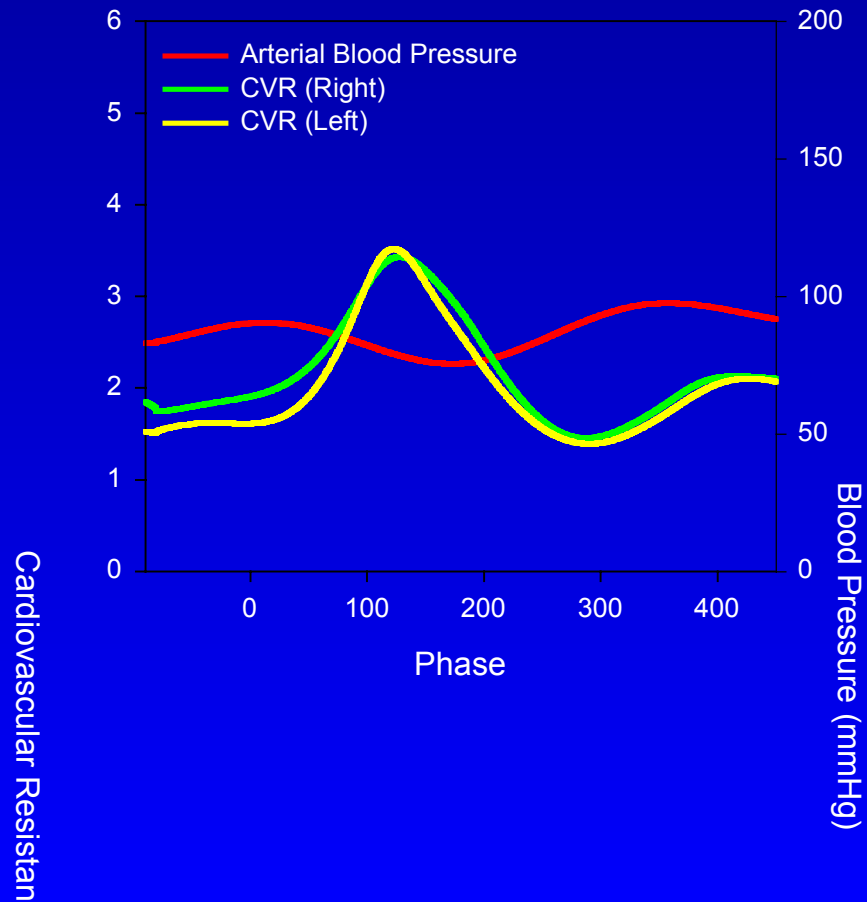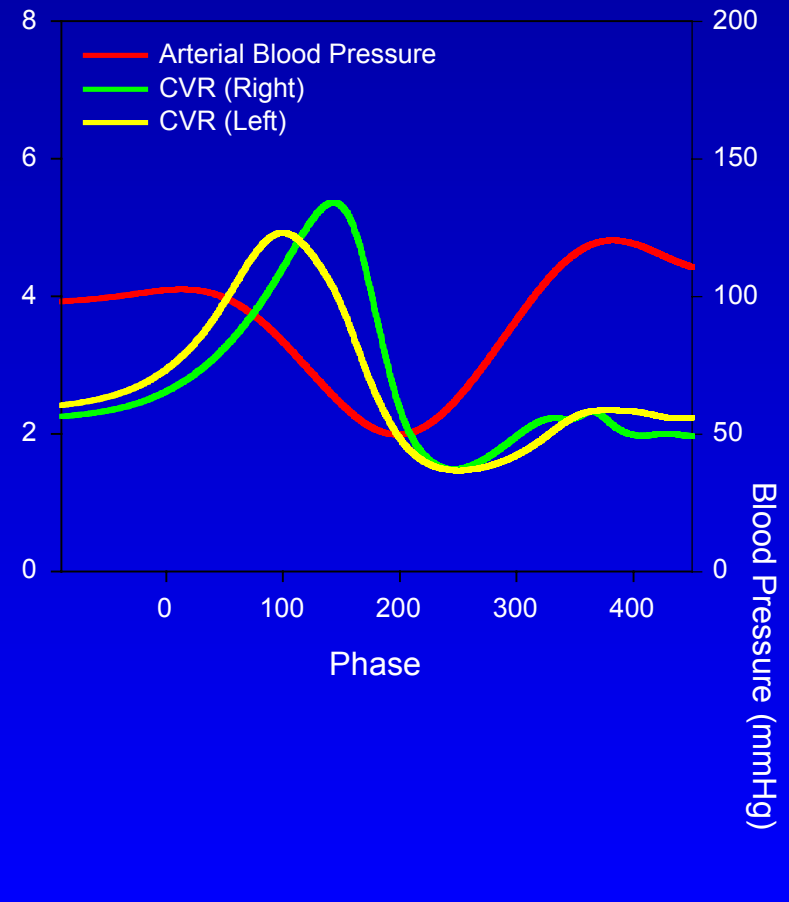
Conclusions

- HHT has great potential to revolutionize biomedical signal analysis.

- Clinical applications of HHT can have immense impact on public health.

Cautions of Technology Transfer

- HHT algorithm needs to be individually adapted for each application; off-the-shelf usage could give misleading results.

- Interdisciplinary expertise and high quality databases are critical to the implementation and evaluation of HHT applications

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